P[illegible]GB 2003 / 001427

01 APRIL 2003

INVESTOR IN PEOPLE

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

PRIORITY DOCUMENT

SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

REC'D 23 APR 2003

WIPO PCT

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed M Cunkie

Dated 17 December 2002

THE PATENT OFFICE
C
18 OCT 2002
NEWPORT

The Patent Office

0224250.1

Patents Form 1/77

Patents Act 1977

1/77

Request for grant of a patent
Grant

180CT02 E75...
P01/7700 0...

The Patent Office
Concept House
Cardiff Road
Newport
Gwent NP10 8QQ

1.	Your reference	2343-P101-GB
2.	Patent application number	0224250.1
3.	Full name, address and postcode of the or of each applicant *(underline all surnames)*	WOOTON, Shane Richard No. 3 The Heronry Lakeside View Penistone Barnsley S36 7EX United Kingdom
	Patents ADP number *(if you know it)*	8486417000
	If the applicant is a corporate body, give the country/state of its incorporation	N/A
4.	Title of the invention	Dispensing Material Produced by a Chemical Reaction
5.	Name of your agent	ATKINSON BURRINGTON
	"Address for service" in the United Kingdom to which all correspondence should be sent	25-29 President Buildings President Way Sheffield S4 7UR GB
	Telephone No:	0114 275 2400
	Patents ADP number	7807043001

		Country	Priority application number *(if you know it)*	Date of filing *(day/month/year)*
6.	If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number	N/A	N/A	N/A

		Number of earlier application	Date of filing (day/*month/year*)
7.	If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	N/A	N/A

8.	Is a statement of inventorship and of right to grant of a patent required in support of this request?	No

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	15
Claim(s)	04
Abstract	00
Drawings	06 6. RM

10. If you are also filing any of the following, state how many against each item.

Priority documents	N/A
Translations of priority documents	N/A
Statement of inventorship and right to grant of a patent (*Patents Form 7/77*)	N/A
Request for preliminary examination and search (*Patents Form 9/77*)	None
Request for substantive examination (*Patents Form 10/77*)	None
Any other documents (*Please specify*)	

11. I/We request the grant of a patent on the basis of this application.

Signature

Date Thursday, 17 October 2002

12. Name and daytime telephone number of person to contact in the United Kingdom

RALPH ATKINSON CPA
0114 275 2400

Dispensing Material Produced by a Chemical Reaction

Background of the Invention

1. Field of the Invention

The present invention relates to apparatus for dispensing material produced by a chemical reaction between a first chemical re-agent and a second chemical re-agent. The dispensed material may be foam-like or elastameric. Preferably, the material is in a fluid state allowing it to be cast and then cured into a substantially solid construction.

2. Description of the Related Art

Foam-like material such as polyurethane is produced in situ so that it expands and sets into required shapes. A first chemical re-agent may be a diol and a second chemical re-agent may be a diisocyanate. In addition, small amounts of water are added to the reaction mixture during the polymerisation process to produce carbon dioxide gas that acts as the foaming agent.

High pressure systems are known in which the chemical re-agents are brought into contact under high velocity having been released from respective high pressure nozzles. High pressure systems of this type produce good quality polyurethane foam and require minimal maintenance. However, a problem with these systems is that output rates tend to be relatively high and attempts to scale down output production by reducing the size of the apparatus, and thereby reducing the volume of material released from the respective nozzles, have introduced further engineering difficulties.

Low pressure systems are known that use mechanical mixing operations and are thereby capable of operating at lower output rates/volumes. However, low pressure systems introduce further problems in that the quality of the mix tends to be lower than that produced by high pressure systems and organic solvents are required on a regular basis to effect the cleaning of a mixing chamber. In both of these known systems the rate of foam production is controlled by controlling the flow of the individual re-agents.

Brief Summary of the Invention

According to an aspect of the present invention, there is provided an apparatus for dispensing material produced by a chemical reaction between a first chemical re-agent and a second chemical re-agent, wherein said material is produced intermittently at a first rate of production; said produced material is held temporarily at a dispensing device; and said temporarily held material is dispensed from said dispensing device at a second rate of dispensing.

By providing for the temporary holding of reacting material, it is possible for the material to be produced at a first high rate thereby making use of preferred high pressure techniques. Therefore the foam-like material may be dispensed at much lower rates, consistent with low pressure systems while taking advantage of the improved mixing qualities of the high pressure system and without requiring environmentally unfriendly organic solvents for cleaning purposes.

Brief Description of the Several Views of the Drawings

Figure 1 shows an example of A chemical reaction for producing a foam-like polyurethane;

Figure 2 shows a facility for the production of air filters;

Figure 3 illustrates a device for dispensing material;

Figure 4 illustrates the operation of the device shown in *Figure 3*, including a dispensing head;

Figure 5 details the dispensing head identified in *Figure 4*;

Figure 6 illustrates operations performed by a computer control system.

Written Description of the Best Mode for Carrying Out the Invention

Figure 1

An example of a material that is produced by a chemical reaction between a first chemical component and a second chemical component is polyurethane. A urethane **101** is produced when an alcohol **102** reacts with an isosyanate **103.** Typically, polyurethanes **104** are made by reacting a diol **105** with a diisocyanate **106.** Preferably, large diisocytanate molecules are deployed as these are less hazardous.

Figure 2

Polyurethanes, and similar materials, have may applications in situations where flexible light-weight materials are required. For the purpose of providing an illustration only, a facility is shown in *Figure 2* for the production of air filters. A plurality of stations **201, 202** etc are provided

in a substantially circular configuration. A robotically controlled arm is positioned at a first station so as to apply an edge of fluid unset polyurethane onto which an air filter membrane is applied. The air filter membrane is secured in place as the applied polyurethane foam sets after a curing period. The number of stations provided in the assembly is therefore configured such that the application of polyurethane may be substantially continual, with an air filter being removed prior to a new filter being constructed at the station in question.

The amount of polyurethane required in order to construct an air filter using the facility shown in *Figure 2* is relatively low and a relatively low production rate is required as the polyurethane is being laid into a mould prior to the filter membrane being applied. Consequently, there are difficulties in terms of using high pressure systems therefore there has been a tendency towards using low pressure systems, with the inherent disadvantages previously discussed. The present preferred embodiment allows a relatively low flow of polyurethane to be produced as required by the production facility shown in *Figure 2* while at the same time allowing materials to be reacted at high pressure thereby improving quality and removing the need for cleaning procedures using organic solvents.

Figure 3

A device for dispensing material in accordance with the present preferred embodiment is illustrated in *Figure 3*. In this example, the material is polyurethane being dispensed for the production of air filters as described with respect to *Figure 2*, purely as an illustrative example.

A first chemical component is stored in a first storage container **301** with the second being stored in a second storage container **302**. Pumping devices **303** provide for circulation of the reactants and their application to nozzles at high pressure. Reacted polyurethane foam is dispensed from a head **304** and the overall operation of the device is controlled by a computer system **305**.

Figure 4

Operation of the dispensing device illustrated in *Figure 3* will be described with reference to the schematic representation shown in *Figure 4*. A pump **401** pumps the first chemical re-agent from the first storage container **301**. A valve **402** may be placed in a first position such that the re-agent is returned to the storage container **301**. Similarly, a second pump **403** pumps the second chemical re-agent from the second container **302**. A valve **404** when placed in its first condition returns the second re-agent to the second container **302**. When polyurethane foam is required, either in response to manual operation or in response to program controlled robotics, both valves **402** and **404** are placed in their alternative condition thereby supplying the first chemical re-agent and the second chemical re-agent to the mixing head **304**.

In conventional mixing heads polyurethane foam is expelled in response to the re-agents being supplied to the head. Thus, the rate of polyurethane output is directly controlled in response to the input rate of the component re-agents in known systems. In the present preferred embodiment, the head **304** consists of a reaction chamber **405** and an output dispensing chamber **406**. The dispensable material is generated

within the input reaction chamber **405** under a procedure that is substantially similar to conventional high pressure/high velocity techniques. However, this relatively high volume production is not sent directly to an output port **407**. As the material is created, it is supplied to an output dispensing chamber **406** and held in this output chamber. Having filled the output dispensing chamber **406** to a required amount, material is then dispensed from the output dispensing chamber **406** via the output port **407**. In this way, the rate at which material is released from the output dispensing chamber **406** is independent of the rate at which the dispensable material is generated within the input reaction chamber 405.

Figure 5

A cross section of head **304** is illustrated in *Figure 5*. This consists of a relatively small input reaction chamber **405** having a volume of typically one cubic centimetre. This is connected to the output dispensing chamber **406** having a volume of typically one hundred cubic centimetres or typically in a range from five cubic centimetres to two hundred and fifty cubic centimetres. The first chemical re-agent is supplied to a first reaction nozzle **501** and the second chemical re-agent is supplied to a second reaction nozzle **502**. When valves **402** and **404** are placed in their alternative conditions, the first re-agent released from nozzle **501** is brought into violent contact with the second re-agent released from nozzle **502** at high impact velocity. This results in dispensable material (polyurethane in this illustrative example) being generated at a relatively high rate as it is supplied into the output dispensing chamber **406**.

The output dispensing chamber **406** includes an output orifice **503** and an output pipe **504** extending from said output orifice **503**. Prior to the generation of polyurethane an output control rod **505** descends in the direction of arrow **506** in order to block the output orifice **503**. The output control rod **505** is surrounded by a dispensing piston **507**. Prior to the generation of polyurethane within the input reaction chamber, the dispensing piston **507** ascends in the direction of arrow **508** in order to create vacuum conditions within the output dispensing chamber **405**. Thus, as the foam-like material is produced by the chemical reaction within the input reaction chamber **406**, said foam is received within the output dispensing chamber **406** where it is allowed to continue to expand and react and possibly expand.

In the majority of preferred applications, the input reaction will tend to occur relatively quickly resulting in the output dispensing chamber being filled relatively quickly. The material held temporarily within the dispensing device will then be dispensed at a relatively slower rate thereby allowing the head to dispense polyurethane foam in environments where a relatively slow flow-rate is required. However, it is appreciated that all of the material contained within the output dispensing chamber **406** must be removed while the material remains in a fluid state. Thus, in this way, high quality material may be produced, due to the high pressure mixing while being dispensed at a relatively lower rate thereby increasing the number of applications where high pressure mixed material may be deployed.

The dispensing of material is initiated by the movement of output control rod **505** in an upwards direction, that is in the opposite direction to arrow **506**, thereby opening the output orifice **503**. Thereafter, dispensing

piston **507** is forced to move in a downward direction, that is in the opposite direction to arrow **508**, thereby forcing the produced material to be dispensed through the output pipe **504** via the output orifice **503**. The output control rod **505** is raised such that its bottom surface **509** becomes level with line **510**. This is because after a number of operations there will tend to be a build-up of solid polyurethane at the bottom of the output dispensing chamber **406**.

The dispensing piston **507** dispenses measured quantities of output material and sensors are provided to ensure that the computer control system **305** receives information specifying the exact position of the dispensing piston **507**. Thus, it is possible for the computer system **505** to calculate whether sufficient material is contained within the output dispensing chamber **406** for a further unit output to be generated. In this way, unit outputs continue to be generated until the output chamber is determined to be empty whereupon the entire cycle may repeat and further material may be generated within the input reaction chamber **406**.

As the overall cycle repeats, 'there will be a tendency for more and more reacted polyurethane to accumulate at the bottom of the output dispensing chamber **406**. Consequently, the computer control system **305** only permits a pre-determined number of cycles to be performed before performing a expunging operation. Under normal operation the piston **507** is pushed downwards to a pre-determined extent before it is determined that the output dispensing chamber is considered to be empty and the cycle is repeated. However, in an expunging operation, the dispensing piston is lowered to a greater extent effectively bringing it flush with the inside surface of the bottom of the output dispensing chamber **406**. Under these

conditions the excess build up of reacted material is expressed through orifices **511** extending through the output dispensing chamber. Initially, orifices **511** are blocked with reacted material, whereafter, expunging operations will result in reacted material being expressed through the orifices while leaving the orifices in a blocked condition such that the cycle may repeat.

Figure 6

Operations performed by the computer control system (or similar such as a programmed logic controller or a micro-controller etc) **305** in order control the dispensing of the material are illustrated in *Figure 6*. Step **601** represents a set-up procedure where it is possible to adjust the relative volumes of the two reacting components. Thus, in many applications an even mix of diol and diisocyanate is required but for specialist applications an alternative mix may be preferred. Experience has shown that when alternative mixes are required even greater problems are encountered in terms of producing low volumes using high pressure techniques. The set-up procedures also specify the dispensed volume in terms of the total amount of material required for a specified time. The set-up procedures also identify the dispense rate. In many applications, material is not being dispensed continuously. The dispense rate value therefore represents the rate at which material is released when it is actually being dispensed. The dispensed volume refers to the total volume required over unit time and therefore takes account of periods when material is not being released.

It should be appreciated that many other set up parameters may be specified and that the procedures identified in *Figure 6* would form part of a

much larger set of procedures for controlling the entire operation. Operations of the dispensing devices may also be co-ordinated with other computer controlled robotics.

The system includes a device for activating the apparatus to the effect that material is required. This may consist of a manual button or it may consist of an interface from a robotic system. Activation of this button or interface provides an instruction to the effect that the foam-like material is required at the pre-specified dispense rate. Thus, a question is asked at step **602** as to whether the dispenser has been activated and when answered in the negative a wait state is entered at step **603**. Thus, this wait loop continues until the question asked at step **602** is answered in the affirmative to the effect that the dispenser has been activated.

In response to the question asked at step **602** being answered in the affirmative, a question is asked at step **605** as to whether the output dispensing chamber is ready. If material has been generated and is presently held within the output dispensing chamber the question asked at step **604** will be answered in the affirmative. Alternatively, if the output dispensing chamber is empty the question asked at step **604** will be answered in the negative. In response to the question asked at step **604** being answered in the negative, the output in the form of the output orifice **503** is closed by the activation of the output control rod in the direction of arrow **506**.

At step **606** the output dispensing chamber is evacuated by the movement of dispensing piston **507** in the direction of arrow **508**.

At step **607** material is generated by valves **402** and **404** being placed in their alternative condition resulting in the re-agents being

expressed from nozzles **501** and **502** at high velocity. Consequently, material is generated within the input reaction chamber **405** for a pre-determined period under program control so as to provide an appropriate volume of material to the output dispensing chamber **406**.

Having supplied the required amount of material to the output dispensing chamber **406** the output orifice **503** is opened at step **608** by the movement of the output control rod in an upwards direction.

At step **609** a unit of material is dispensed through the output pipe **504** whereafter a question is then asked at step **610** as to whether the operation is complete. When answered in the negative control is returned to step **602** which, in a first iteration, would tend to result in a question at step **602** being answered in the affirmative to the effect that the dispenser is still activated. On the previous cycle, the output dispensing chamber **406** was filled therefore the question asked at step **604**, as to whether the output dispenser is ready, would tend to be answered in the affirmative. Thus, a further unit of material will be dispensed at step 609 and further iterations around the loop would be effected.

As further operations take place, the output dispensing chamber will eventually be emptied resulting in the question asked at step **604** being answered in the negative. Consequently more material is generated which is then subsequently expelled from the output dispensing chamber. Thus, it can be appreciated that the material is generated under ideal conditions that are not affected by the rate at which the material is ultimately expelled. Eventually, the operation will be completed resulting in the question asked at step **610** being answered in the affirmative.

Conclusions

The preferred embodiment allows the rate at which material is mixed (to initiate chemical reaction) to be separated from the rate at which the output material is dispensed. Experimentation suggests that the material may be held within the output dispensing chamber **406** for a maximum period of twenty seconds. The embodiment allows material to be dispensed at low rates (for example at three grams per second or lower) using equipment that does not need to be cleaned but would normally produce output material at a rate of fifty grams per second. Low dispensing rates usually require low pressure systems to be used which use organic solvents in a cleaning cycle usually taking a minimum of forty five seconds representing system downtime. Thus, the preferred embodiment removes the need for hazardous cleansing materials to be used while at the same time reducing downtimes. This benefits industries such as the previously described manufacture of engine filters where a typical facility may produce of the order of one thousand filters per hour.

The rate of dispensing in the preferred embodiment is fully detached from the rate of mixing therefore the output rate is very flexible. Thus, a single machine may offer many different output flow-rates by simple modifications to the dimensions of the output dispensing chamber.

It is possible to fit two (or more)pouring chambers thereby allowing two types of material to be dispensed from the same head. Under these conditions, it is possible to recharge chambers alternately from different chamber types such that the same head may dispense soft or hard material on alternate cycles.

A further advantage of the preferred embodiment is that the pressure at which the material is dispensed from the output orifice **503** is not related to the pressure encountered within the input reaction chamber **405**. Thus, under some circumstances the pressure at which the material is released through orifice **503** may be greater than the pressure encountered within the input reaction chamber **405** during foam formation. The pressure encountered by the output dispensing chamber **406** is not felt by pumps **401** and **403** when valves **402** and **404** are in their closed condition while material is being dispensed. When operating at high pressures, an additional plate would be required over the bottom surface of the output dispensing chamber **406** having holes that may be aligned with the holes **511** shown in *Figure 5*. Rotation of this plate would place the holes either in phase or out of phase; the out of phase condition being used during the high pressure dispensing with the in phase condition being used during the expunging of collected material.

In an alternative embodiment, colour is injected down the centre of the input reaction chamber **405** so as to provide efficient mixing of colour pigments prior to the material being received within the output dispensing chamber **406**.

During operation, the volume of the output dispensing chamber is effectively variable given that the extent to which dispensing piston **507** is raised may be adjusted.

The provision of the output control rod **505** ensures that there is no leakage when material is not required. In the event of power failure, both the input reaction chamber and the output dispensing chamber are closed and the output control rod is raised so as to open the dispensing orifice

503. Consequently, it is not possible for material to set and cure within either the input reaction chamber **405** or the output dispensing chamber **406**. In this way, it is possible for production to restart without requiring additional cleaning operations to be performed.

The ability to adjust the rates at which material is dispensed provides an opportunity for the dispensed rate to be controlled and adjusted within a particular dispensing operation. Thus, for example, when producing a foam bead it would be possible for part of the bead to have a larger area by increasing the rate at which the material is released as an alternative to reducing the speed of a robotic movement. This greater flexibility may increase production speeds and may reduce mechanical constraints placed upon robotic operations.

In a standard high pressure system, a mixing head is required to open and close at each pouring of material. A start of mixing and an end of mixing create situations of pour impingement due to the deflecting effect created by the blind end section of the groove mixing piston. Thus, situations often occur in which the start of a flow and the end of a flow are sub-standard and this may result in products being rejected. In the present preferred embodiment, material created at the start of material production and at the end of material production are mixed together within the output dispensing chamber such that material released from the output dispensing chamber 406 is substantially homogenous.

Standard high pressure mixing heads perform a finite number of cycles before periodic maintenance is required. Typically, a mixing head will perform five thousand to five hundred thousand cycles depending upon the type of materials being processed. In some situations relatively short bursts

of activity are required to produce relatively small volumes and this in turn will lead to a shorter active life. The present embodiment allows a number of activations within the input reaction chamber to be reduced given that more material may be produced on each activation and then held temporarily within the output dispensing chamber.

In a preferred embodiment, the tolerance between the dispensing piston **507** and the inside wall of the output dispensing chamber **406** will be between ten microns and fifteen microns. Preferably, the diameter of the dispensing piston **507** will be approximately fifty millimetres requiring a dispensing force of in the region of four hundred kilograms. Preferably, the output control rod **505** will have a diameter of ten millimetres and the total area of contact between all moving surfaces will be sufficient to provide effective sealing but will not be so great as to create sticking problems.

Claims

1. Apparatus for dispensing material produced by a chemical reaction between a first chemical re-agent and a second chemical re-agent, wherein

said material is produced intermittently at a first rate of production;

said produced material is held temporarily at a dispensing device; and

said temporarily held material is dispensed from said dispensing device at a second rate of dispensing.

2. Apparatus according to claim 1, wherein said dispensed material is polyurethane produced by reacting a diol as the first chemical re-agent with a diisocyanate as the second chemical re-agent.

3. Apparatus according to claim 1, wherein said first rate of production is relatively high.

4. Apparatus according to claim 1, wherein said material is produced by ejecting said first chemical re-agent from a first nozzle under high pressure and by ejecting said second chemical re-agent out of a second nozzle under high pressure.

5. Apparatus according to claim 1, wherein said second rate is relatively low.

6. Apparatus according to claim 1, including a dispensing chamber for temporarily holding said material.

7. Apparatus according to claim 6, wherein said dispensing chamber includes an orifice and a piston for dispensing said material from said orifice.

8. Apparatus according to claim 7, including closing means for closing said orifice during material production.

9. Apparatus according to claim 1, including expunging means for removing built-up reacted material.

10. Apparatus according to claim 1, including input interface means for receiving command instructions from a programmable control system.

11. A method of dispensing material produced by a chemical reaction between a first chemical re-agent and a second chemical re-agent, comprising the steps of

producing material intermittently at a first rate of production;

holding said produced material temporarily;

dispensing said temporarily held material at a second rate of dispensing.

12. A method according to claim 11, wherein said dispensed material is polyurethane produced by reacting a diol as the first chemical re-agent with a diisocyanate as a second chemical re-agent.

13. A method according to claim 11, wherein said first rate of production is relatively high.

14. A method according to claim 11, wherein said material is produced by ejecting said first chemical re-agent from a first nozzle under high pressure and by ejecting said second chemical re-agent out of a second nozzle under high pressure.

15. A method according to claim 11, wherein said second rate is relatively low.

16. A method according to claim 11, including a dispensing chamber for temporarily holding said material.

17. A method according to claim 16, wherein said dispensing chamber includes an orifice and a piston for dispensing said material from said orifice.

18. A method according to claim 17, including closing means for closing said orifice during material production.

19. A method according to claim **11**, including expunging means for removing built-up reacted material.

20. A method according to claim **11**, where in operations are controlled in response to instructions received from a programmable control system.

21. Apparatus for dispensing material substantially as herein described with reference to *Figures 3*, *4* and *5*.

22. A method of dispensing materials substantially as herein described with reference to *Figures 4*, *5* and *6*.

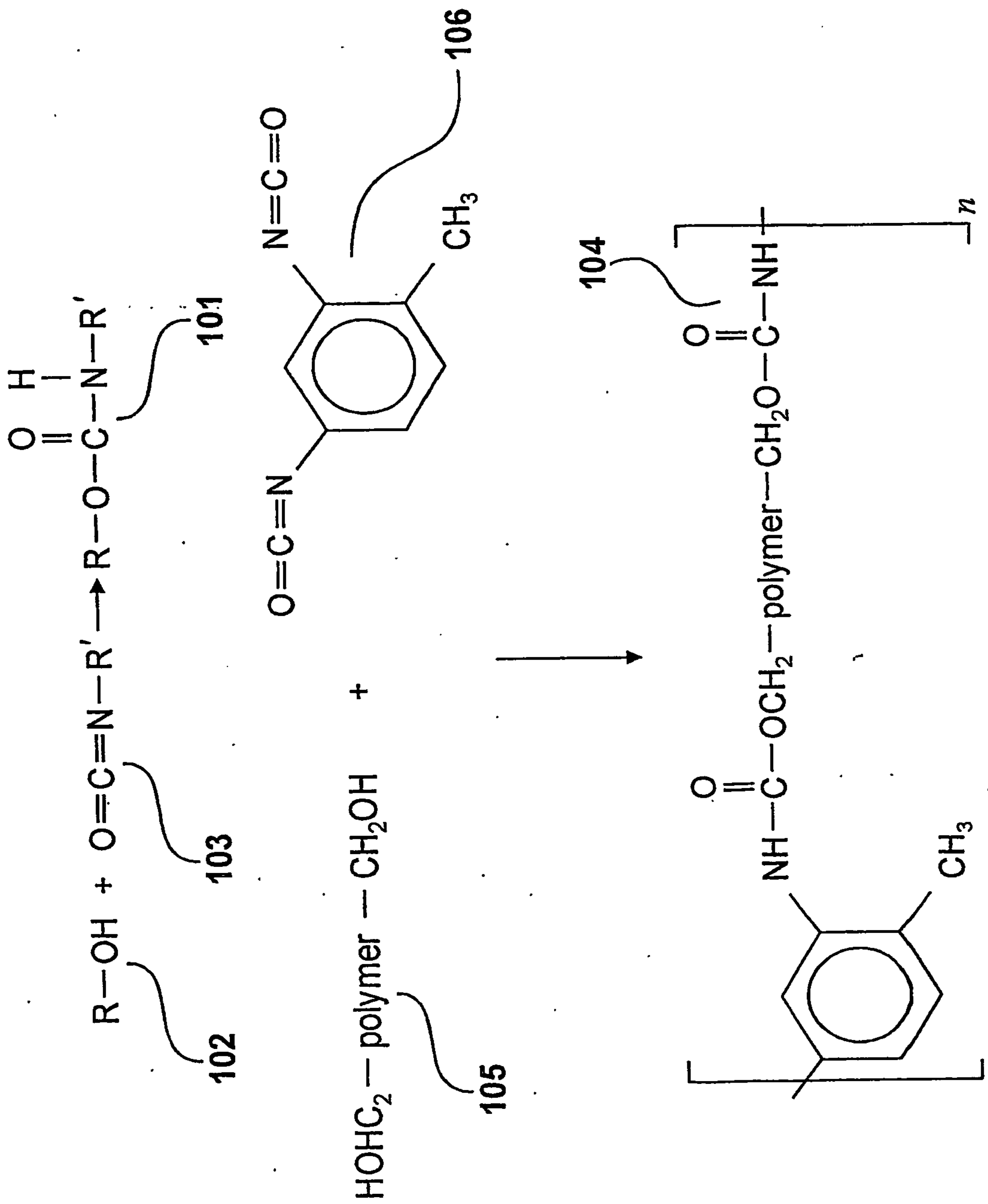

Figure 1

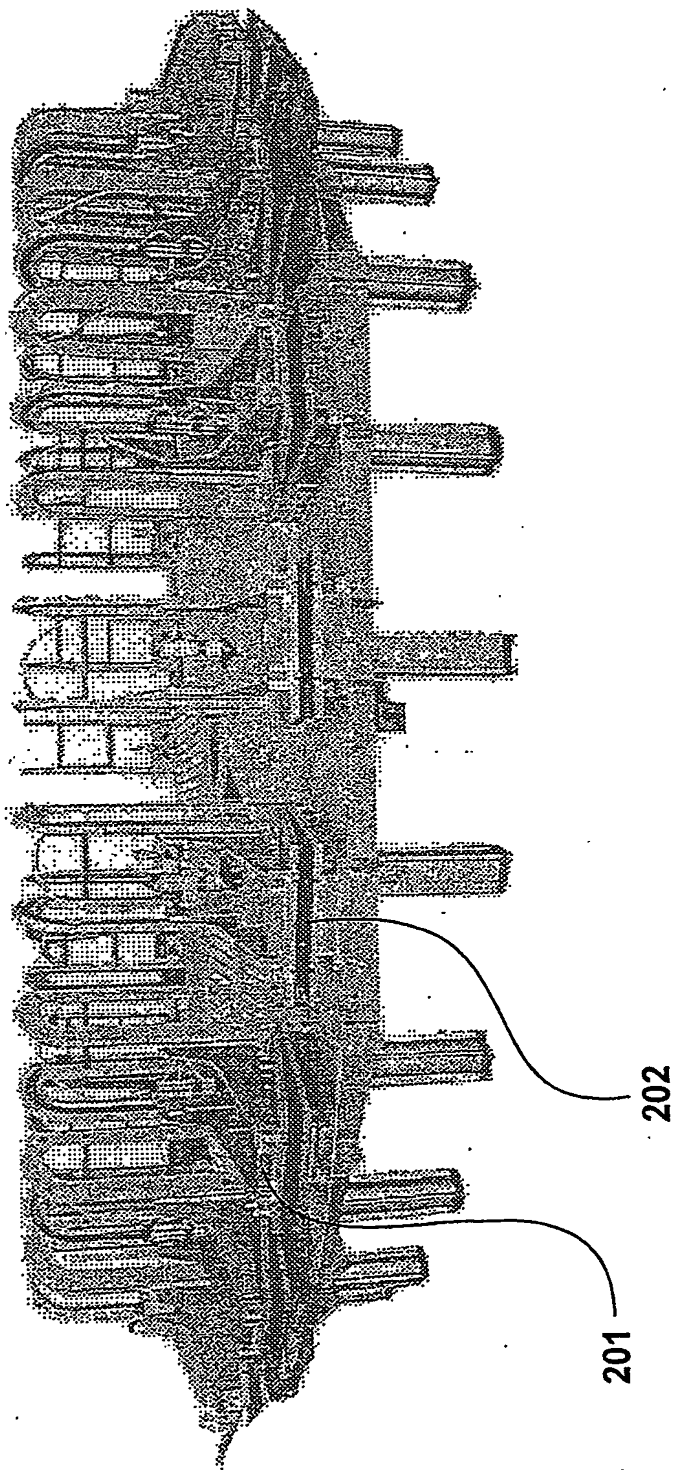

Figure 2

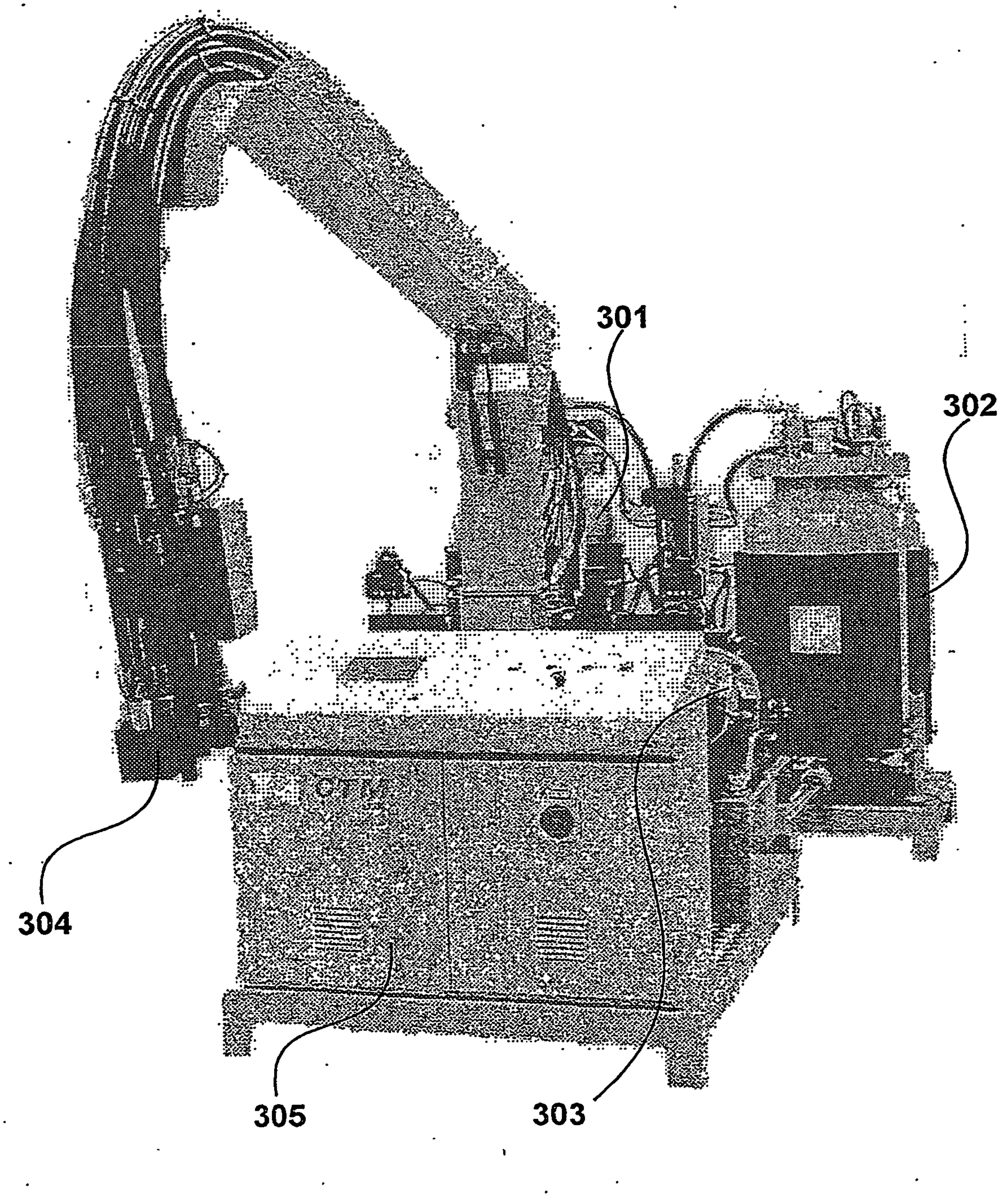

Figure 3

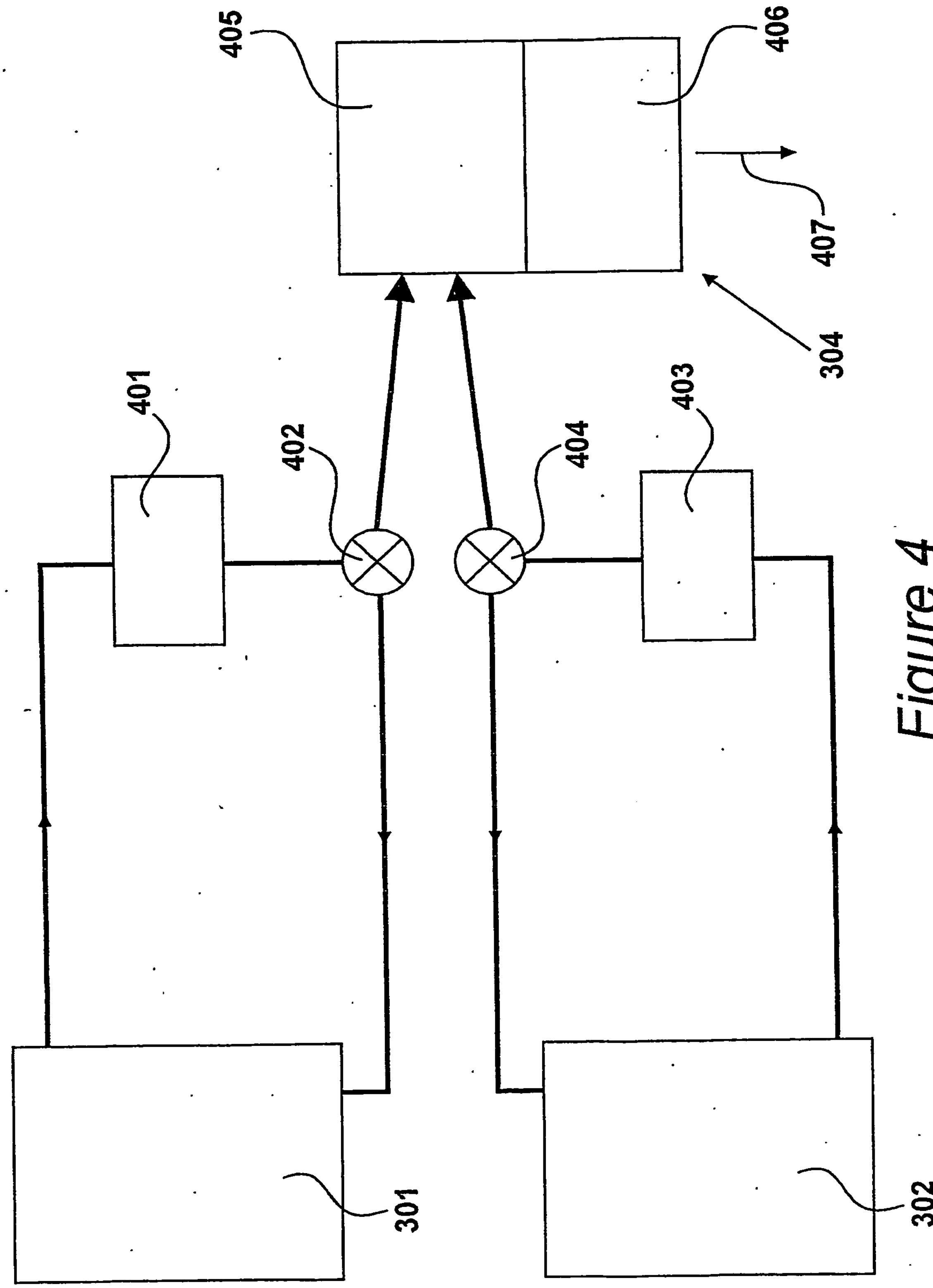

Figure 4

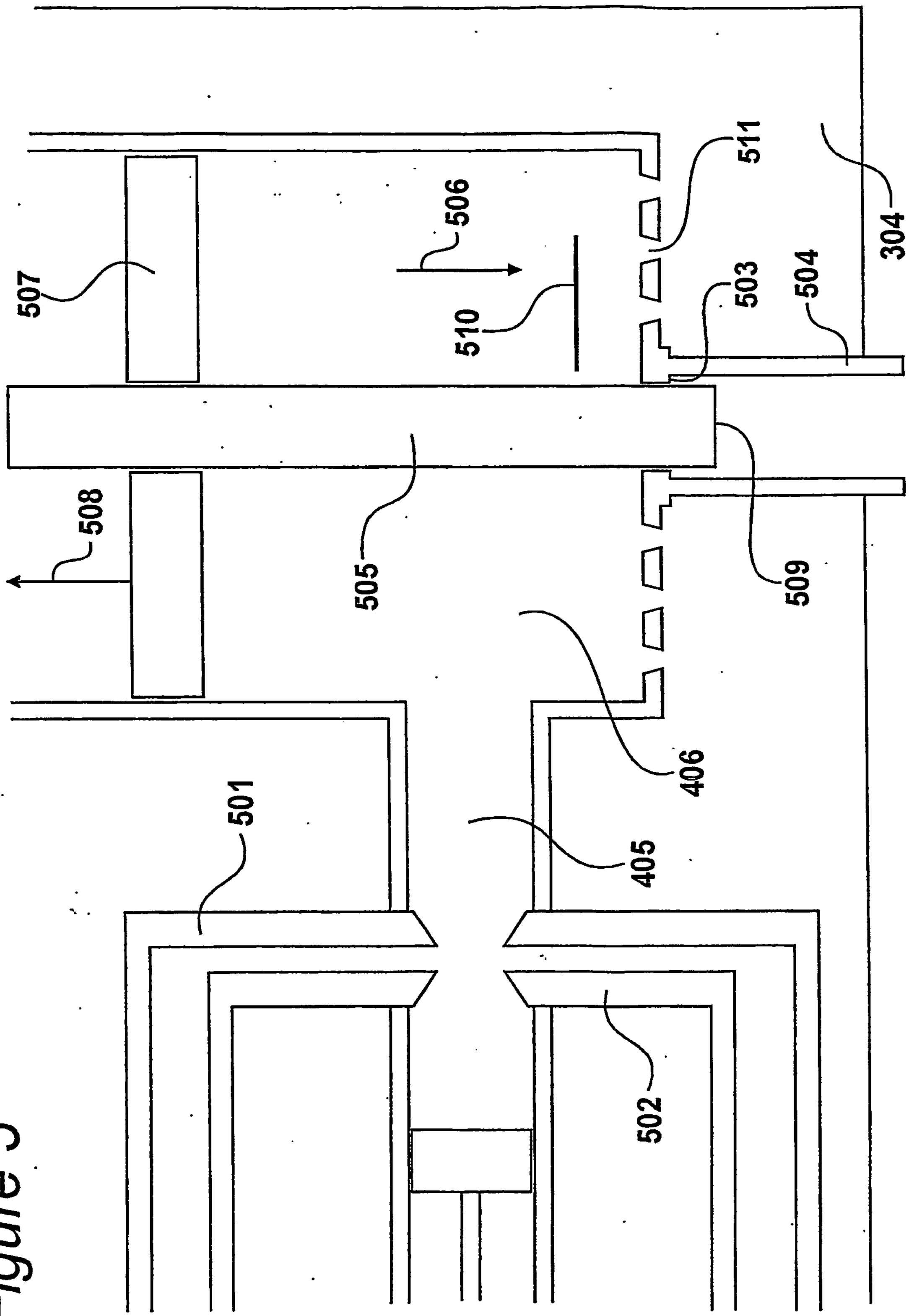

Figure 5

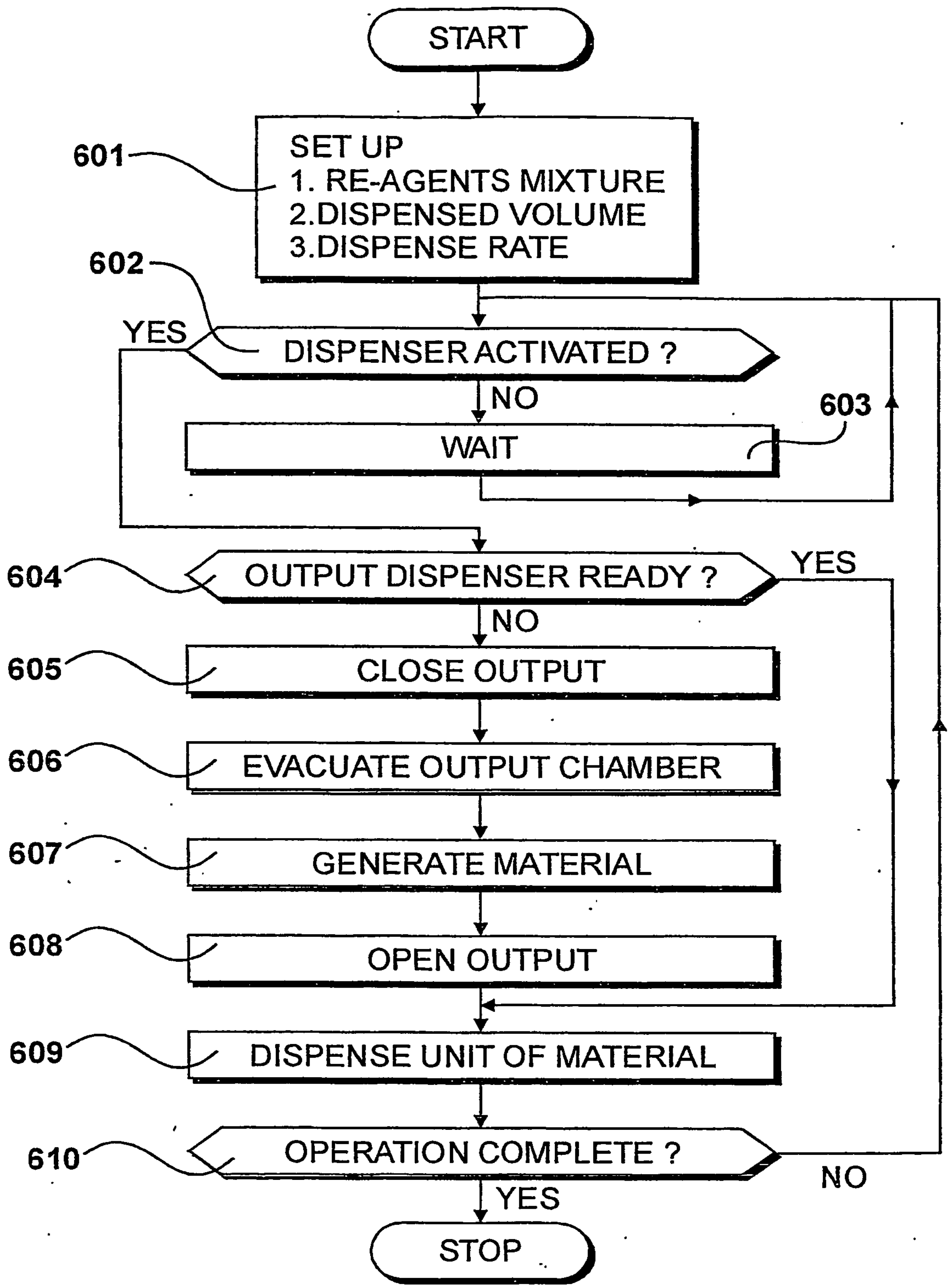
START
SET UP
1. RE-AGENTS MIXTURE
2.DISPENSED VOLUME
3.DISPENSE RATE
601
602
YES
DISPENSER ACTIVATED ?
NO
WAIT
603
604
OUTPUT DISPENSER READY ?
YES
NO
605
CLOSE OUTPUT
606
EVACUATE OUTPUT CHAMBER
607
GENERATE MATERIAL
608
OPEN OUTPUT
609
DISPENSE UNIT OF MATERIAL
610
OPERATION COMPLETE ?
NO
YES
STOP

Figure 6